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THE BELL TELEPHONE.

THE result of the legal action which has just been taken by the proprietors of the Bell telephone, or their agents, against two London instrument makers, Mr. O'Reilly and Mr. Ladd, for infringement of their patent rights, will be awaited with considerable interest by the telegraphic profession generally, and to some extent also by the public, for the telephone, by its marvellous powers and simplicity, has become a popular as well as a strictly technical instrument.

All the world has wondered at the speaking telephone of Professor Graham Bell, even for a longer period than the proverbial nine days, and all the world has admired the perseverance and the mechanical genius of its inventor. We believe we are only expressing what is in every man's mind, however, when we say that, although everybody may have wondered at the price which is charged for the instrument wherever a monopoly has been gained, no disinterested person has yet been found who admired it. The telephone is both an eminently fortunate and unfortunate invention. It is fortunate in being a marvel, and well suited for popular use. It is unfortunate in being so exceedingly simple that it can be manufactured for a few shillings. This low cost of production militates against any high royalty which may be charged for it on the grounds that it is a great and novel convenience. The proprietors of the Bell telephone have chosen to ignore its intrinsic cheapness as an instrument, and to charge a very heavy royalty under the monopolies granted them in America and England. They have looked only to the supposed advantages of the instrument, and have set a value on its prestige. The licensed price of a set of telephones, which can be made with a fair profit for ten or twelve shillings, is £25 and £35 sterling. This price includes, it is true, an electric bell alarm arrangement, but that does not cost many shillings more.

By this heavy royalty, which is generally considered to be exorbitant, the possessors of the Bell telephone monopoly have laid themselves open to competition. It is well known that several instrument makers in London and elsewhere, have been for months past retailing all, or nearly all, the separate parts of telephones, ready to be fitted together by the purchaser. It is also well known that many private individuals have made telephones for themselves; and this, notwithstanding an injunction issued by the telephone monopolists, that action would be taken against unlicensed makers, sellers, or users.

However the cases about to be tried may be decided, there can be no doubt, that the proprietors of the Bell telephone monopoly have alienated the public sympathy by their charges. So long as the telephone was surrounded by a halo of sensation, and the wealthy public were ignorant of its real cheapness, their policy may have been at least profitable for the time. Now, however, the telephonic illusion is fast disappearing, it is becoming a familiar instrument, and even its failings are being pointed out. The public are now aware of its inexpensive nature, and, however useful it may be to some people, if they purchase it at all, they will not do it with the best grace. We are much mistaken if the public instinct will countenance a charge determined by arbitrary views of the utility and reputation of an invention; irrespective of its actual cost of production. People cannot afford to pay for such indefinite entities as these entirely. Utility and repute are properly the things which give rise to the demand for an article and not the things which fix its price. Had the proprietors of the Bell telephone fixed their terms in reasonable accordance with the intrinsic value of the instrument, the demand for it would have been enormously multiplied, and we feel sure that, while rendering a real and satisfactory service to the public, they would likewise have defeated surreptitious competition, and realised more money themselves in the end.

THE TELEPHONE IN COURT.

THE telephone has at last made its appearance in Court, and the fight over it is evidently going to be a severe one. The questions that will be raised are of such interest, and the issues at stake so important, that we have thought it would be acceptable to our readers to have the cases closely watched and the results and their bearing laid before them. We therefore propose to notice, under the above heading, the proceedings that are pending, and to make such remarks upon them as may tend to render their effect clear.

The first proceeding was taken on the 8th ult., when an application was made to the Master of the Rolls, on the part of Mr. Morgan Brown, the English patentee of Bell's telephone, to whom the invention was communicated from America by Professor Bell, for an injunction restraining Mr.

O'Reilly, of the Sun Works, West Smithfield, from making and selling telephones or pieces of them. An action is pending for damages in respect of the same matter, in which, if the plaintiff is successful, an injunction to restrain future manufacture and sale would follow, as a matter of course; but the present application was substantially for the purpose of restraining such manufacture and sale *pendente lite*. If the judge were satisfied that the defendant had no real and substantial defence in a case of this sort, he would grant an injunction, as it would be obviously unfair that the plaintiff's monopoly should be damaged. In the present case, the defendant stated in affidavits that he intended, *bonâ fidé*, to dispute the validity of the telephone patent on the grounds, (1st) of want of novelty, (2nd) of prior publication to a sufficient extent to enable a person of ordinary skill to construct the instrument, (3rd) that the specification, as amended by the disclaimer of Feb. 12, 1878, was a bad one. The second ground, which seems a formidable one, is founded on the fact that Professor Bell described the telephone at the Philadelphia Exhibition, and his account was published in England before the date of the plaintiff's patent, viz., Dec. 9, 1877.

The Master of the Rolls said that he was satisfied of the *bonâ fidés* of the defence, and that there were some grounds for it, and should, therefore, take the usual course of letting the matter stand over till the action was disposed of, the defendant meanwhile keeping accounts of his sales.

It appeared in the course of the hearing that a similar action is pending against Mr. Ladd.

The state of business is such in the Rolls Court that any delay which may take place before the case comes on will be due solely to the necessity of obtaining proper scientific evidence, &c., there being no such block in Sir George Jessel's court as there is in some others.

In the meantime, the general public, through the medium of the daily press, are airing some most extraordinary ideas as to what vitiates a patent. A letter from Mr. W. Chappell (for example) appeared in the *Times*, of March 9, which we commend to the notice of our readers as a very good specimen of the sort of writing now current. To such persons we would recommend a study of some elementary work on patent law. The study of it will convince them that the prior invention of a pop-gun will not, at any rate in a court of law, detract from the novelty of a Martini-Henry rifle.

THE Eastern Telegraph Company have contracted to lay a cable for the English Government between Tenedos and Scios.

LOEFFLER AND HIGGS' SIGNALLING ARRANGEMENTS FOR WORKING LONG SUBMARINE CABLES.

IN signalling over land lines or cables of considerable length, the impulses sent from one end of the line arrive at the other end in such a manner, that when they are caused to succeed each other rapidly, they are apt to produce signals running into one another, or otherwise indistinct, or to fail to produce signals, and thus the rapidity of transmission is limited. Various means are applied for remedying this defect with a view to obtain greater distinctness of signals, and to permit greater rapidity of transmitting them. In Messrs. Loeffler and Higgs' apparatus, the receiving instrument is placed by means of a bridge arrangement of suitably regulated resistances, under a definite difference of potential derived from a battery placed at the receiving station in the battery branch of the bridge arrangement, but so that the instrument does not operate for signalling, except when this difference potential is varied by an impulse caused by action at the sending station.

Fig. 1 shews one method of effecting this result:—The line or cable L is connected to the one terminal of the receiving instrument I, and also through a resistance R permanently to one pole of a battery B or other source of electricity, the other pole of which is connected to earth at E. The first-named pole of B is connected through a resistance S to the other terminal of the instrument I, which is also connected through a resistance T to earth. The resistances R, S, T, are so adjusted to each other and to the battery power, and also to the resistance of the line while the sending instrument is quiescent, as to bias the receiving instrument to such an extent that when impulses are transmitted from the sending station either the instrument will not be acted on by the beginning and ending portions of those impulses, during which portions the forces gradually increase and decrease, or that so much force will be added to these portions of the impulses that the receiving instrument will begin to be influenced nearly at the beginning and continue to be influenced nearly up to the determination of each impulse.

When applying the arrangement to a line having considerable capacity, such as a cable, a condenser or combination of condensers, as shewn at C in the diagram, fig. 2, may be connected to the branch S. For the condenser may be substituted equivalent electro-magnets.

A bridge arrangement of like kind may be employed without the separate battery B.

In the arrangement shewn in figs. 1 and 2 the instrument I and the battery B may change places; and in the arrangement, where the separate battery is not employed, the instrument I may be inserted in its place, resistances being properly adjusted.

Fig. 3 shews an arrangement for the purpose mentioned above, in which the four branches of a bridge are combined with the receiving instrument, a combination which is termed a "local bridge." In this arrangement the receiving instrument I is connected by both terminals to the branches *a*, *b*, *c*, *d*, which are equal or so proportioned to one another that the instrument is not affected by any current transmitted by the cable or line L when a condenser

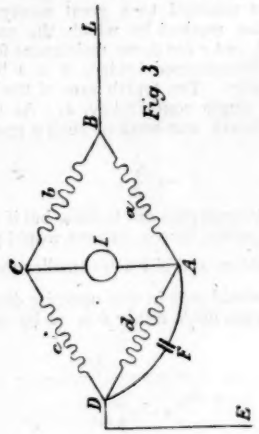


Fig 3

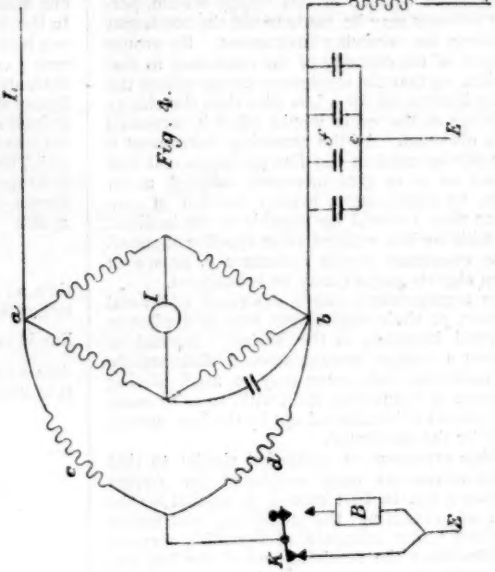


Fig. 4.

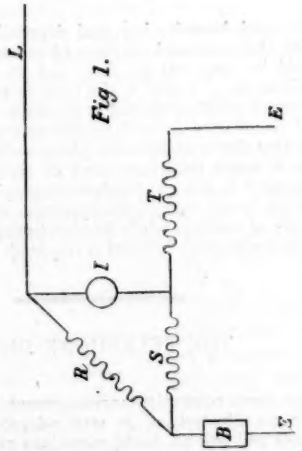


Fig. 1.

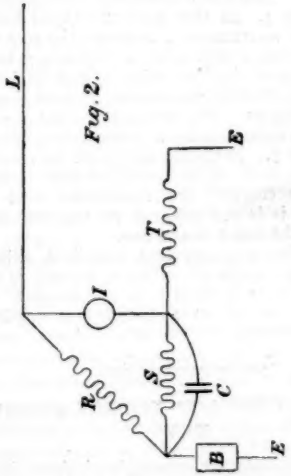


Fig. 2.

F is not connected to one of the branches *a*, *b*, *c*, or *d*. But when such a condenser as F is connected to one of the four branches the receiving instrument is actuated only by the charge and discharge of the condenser. Under certain conditions, by avoiding exact balance of this bridge system, permanent currents may be made to aid the condenser in actuating the receiving instrument. By proper adjustment of the capacity of the condenser to that of the line, so that the condenser charge affects the receiving instrument for a less time than the charge or discharge of the cable would affect it, increased speed is obtained. As the receiving instrument is not directly included in the line circuit its coil may be wound so as to give increased delicacy, as for example, by employing a greater number of convolutions than it would be possible to use in direct circuit with the line without great sacrifice of speed. For the condenser F and resistance *d*, shewn in fig. 4, an electro-magnet may be substituted.

In the arrangements above described additional condensers, or their equivalents, may be applied in the several branches of the bridge. Instead of employing a bridge arrangement, a differentially wound receiving instrument may be used, placing a condenser in connection therewith, so as to cause the instrument to be affected not by the line current but only by the condenser.

A bridge arrangement somewhat similar to that described above has been employed for duplex telegraphing, but in that case it is applied for the purpose of preventing the receiving instrument from acting under influence of signalling currents transmitted from the receiving end of the line, and consequently the resistances and connections are arranged to maintain different electrical conditions.

For duplex telegraphing the "local bridge" combined with known arrangements for duplex working is employed. One such combined arrangement is shown by fig. 4. In this case the "local bridge" enclosing the instrument I is connected at *a* and *b* to the branches *c* and *d* of a duplexing bridge, and also at *a* to the line wire L, and at *b* to an artificial line *e*, *f*, which may consist of condensers, as shown in the figure. The junction of *c* and *d* is connected to the operating key K commanding the poles of the battery B. In this arrangement the receiving instrument is acted on as described with reference to fig. 3 when currents are transmitted to it from the line, but it is not affected by currents transmitted from the key K to the line.

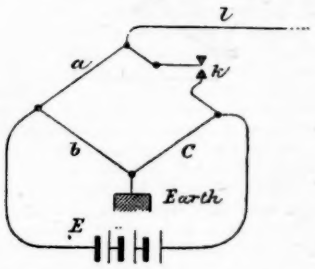
In the bridge arrangements described, although for the sake of simplicity only one battery or other known appliance is shown in the diagram, it is obvious that several such batteries or appliances might be employed.

A SINGLE CONTACT DOUBLE CURRENT KEY.

IN every form of double current key hitherto in use, from two to four contacts have been employed in addition to the switch contacts which cut off the battery and put the line wire through the receiving instrument to earth. Where four contacts are employed, as in the ordinary double current key the play of the lever is necessarily considerable, otherwise false signals are liable to be made. Again, in the latter form of key, the several currents must be of equal strength; and in the submarine keys, where not less than two contacts are employed, it is usual to have two batteries, one for sending a current in one direction and the other for giving a reversal. In the following arrangement, only one contact and one battery is employed for sending reversed currents; and, moreover, the relative strengths of these currents can be adjusted to a great nicety. The figure shows the method by which the result is arrived at. *a*, *b*, and *c* are three resistances forming the arms of a Wheatstone bridge, E is a battery, and *l*, the line wire. The fourth arm of the bridge is formed by a single contact key, *k*. As is well known, if this fourth arm were of such a resistance *x*, that

$$x = \frac{a\,c}{b}$$

then no current would pass out to line; but if *x* were larger than this value, then a current would pass to line in one direction, and if *x* were smaller than $\frac{a\,c}{b}$ then a current would pass in the opposite direction. It is clear if *x* were made either *0* or ∞ by making



this fourth branch a key, and depressing or leaving it up, that reversed currents of maximum strength could be sent out to line, and by adjusting the resistances *a*, *b* and *c*, the relative values of these currents could be altered at pleasure.

A peculiarity in the arrangement consists in the fact that the reversal takes place without any break, and it might therefore prove of service as a "pole changer" in the quadruplex telegraph system, and, indeed, in any telegraphic apparatus where a multiplicity of contacts might be objectionable, and where an instantaneous reversal is required.

H. R. K.

THE TELEPHONE DESK.

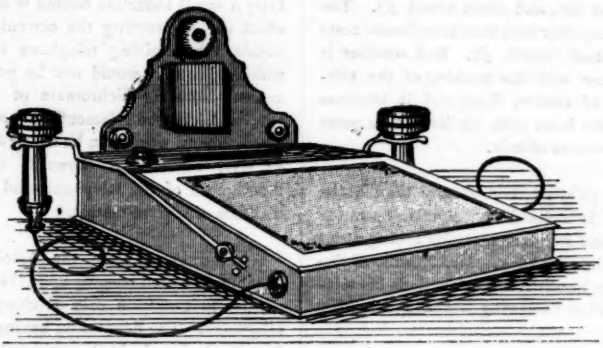
THIS very convenient arrangement, of which we give an illustration, is well adapted for private offices and will no doubt come into extensive use.

It consists of an ordinary office desk provided with a trembling bell on a board at the back. A call button is placed at the corner of the desk, and on each side are brass brackets in which two telephones normally rest.

One of the brackets is connected to the line wire

and is hinged and plays between two contact points. Of these latter, one is in circuit with the telephones and the other with the bell.

The weight of the telephone in the hinged bracket presses the latter down on the bell contact point, so that, normally, the bell is in circuit with the line.



The desks at both ends of the line have similar connections, and are provided with batteries which ring the bells when the call buttons are pressed.

In working the arrangement then; when the attention of either station has been called on its bells by pressing the call button at the other station, the former replies by pressing his own button to notify that he has observed the call, and then both stations taking their respective telephones out of their brackets, the hinged brackets rise slightly under the influence of springs and put the telephones in circuit; the correspondence is then carried on. On the completion of the communications the telephones are returned to their brackets, and the bells become again put in circuit.

Notes.

THERE was a very full assembly at the meeting of the Society of Telegraph Engineers on Wednesday, the 27th Feb., owing to the announcement that Mr. W. H. Preece would exhibit the phonograph. Electricians were curious to see this wonderful instrument, and to hear for themselves whether or not its actual performances justified its astonishing repute. Three different phonographs were tried, but precedence was of course given to one sent over from America by the inventor, Mr. Edison. There was absolute silence in the hall, followed by a burst of surprise and delighted applause, when the little piece of mechanism on the table plainly uttered, with a comical assurance all its own, "The phonograph presents his compliments to the audience." It then recited poetry, sang songs, coughed and crowed, laughed heartily, and gave vent to a succession of jubilant hurrahs. One after another, this amusing parody of human speech truthfully expressed a variety of emotions, enthusiasm, merriment, patriotism, and even pathos, and proved itself capable of reproducing, at least to a certain extent, individual tone and manner. In its present form, however, it has a characteristic individuality of its own which disguises the voices of the speakers which it mimics. But this only heightens the illusion of its own personality. The phonograph, above all other instruments, fills us with that strange sense of the individual life of a machine. Orderly motion is at the root of this impression, and speech added completes the effect. It is when we see an instrument like this in operation that we get a glimpse of the full glory of invention; and we cannot but admire the audacity of genius which has led Mr. Edison with means so simple to realize such marvellous results. At the conclusion of the meeting the phonograph (after having been charged by Mr. Spagnoletti) gave the National Anthem with quite a stirring effect; and it was as much a compliment to Mr. Edison, and a tribute to the powers of the instrument, as a mark of loyalty to the Queen, that the audience the while remained standing.

MR. EDISON has devised a means of driving sewing machines by a vibrating tuning-fork. The fork is maintained in vibration by a pair of electro-magnets, actuated by a battery whose circuit is interrupted timeously by the arms of the fork. Between the arms of the fork there is a "ratchet" wheel, and each arm carries a "cleet" which works into the wheel—one on the top, the other underneath. When the fork is started into vibration the wheel is rotated, and a grooved pulley, carried by the same axle as the wheel, communicates the motion of the wheel to the parts of the sewing machine.

TELEPHONIANA.—The telephone has been adopted into the outpost system of the Russian army. The line employed is a light cheap cable, which can be laid over any kind of ground by one man. It is in lengths of from 400 to 500 metres, this being the average distance between pickets and supports, and consists of two insulated copper wires. Each length weighs from 8 to 10 lbs., and costs about £3. The winding apparatus, together with two telephones, costs £1 more—total for each length, £4. Bad weather is not found to interfere with the working of the telephones; but noise, of course, does, and it becomes necessary to cover the head with the hood of a great coat to exclude extraneous sounds.

MR. W. ACKROYD points out in *Nature* that in the human ear the drum is inclined to the axis of the ear at an angle of 46°, and suggests that this arrangement should be imitated in telephony. Mr. Newth, of the Chemical Laboratory, South Kensington, finds his telephone to work best when he speaks into it in a slanting direction.

IN order to compare the intensity of sounds as given out by the telephone with their original intensity, M. Demoget, of Nantes, has experimented with two Bell telephones in an open field. He held one of these to his ear, whilst his son at a distance kept repeating the same syllable with the same intensity of voice into the second instrument. He compared in this way the sound heard from the telephone with that heard from the speaker, and calculated their relative intensities from the relative distances of their sources from his ear. When the telephone was held about 5 centimetres from his ear, and the distance of the speaker was 90 metres, the direct and telephonic sounds were of equal intensity, and the ratio of the intensities at the source was therefore as 25 to 81,000,000; in other words, the sound transmitted by the telephone was only about $\frac{1}{3000000}$ of the sound emitted. Owing to the influence of the ground, however, the stations could not be considered as points in free space, and M. Demoget therefore alters this ratio to $\frac{1}{1500000}$. From the fact that the intensities of two sounds are proportional to the square of the amplitude of the vibrations, it follows that the vibrations of the two plates of the telephones were directly proportional to the distances, that is to say as 5 is to 9,000 (centimetres), and that the vibrations of the receiving telephone are 1,800 times smaller than those of the transmitting telephone. They are, therefore, comparable to molecular vibrations. M. Demoget, without wishing to diminish in anything the merit of Bell's invention, concludes from these results that the telephone as a machine leaves much to be desired since it can only transmit $\frac{1}{1800}$ of the original work, and remarks that its results, so unexpected, are due rather to the perfection of the organ of hearing than to the perfection of the instrument.

MM. POLLARD AND GARNIER continue their telephonic experiments with a transmitter on Edison's carbon-contact principle, and a Bell telephone connected to the line through an induction coil as a receiver. Such is their success that Count du Moncel is of opinion that this union of the telephones of Bell and Edison will solve the problem of telephony on a practical scale. Only a small induction bobbin is necessary; it has the effect of accentuating the current, so to speak, and it causes the receiving telephone to articulate sounds which without it would not be produced. When the current from six bichromate of potash elements or twelve Léclanché elements is employed with this arrangement, words can be heard at a distance of fifty or sixty centimetres (upwards of 1½ ft.) from the mouthpiece of the telephone, and musical sounds at a distance of several metres.

A DEPUTATION from the Associated Chambers of Commerce waited recently upon the Postmaster-General relative to a uniform rate of charge for all European telegrams. The deputation having been introduced by Mr. S. S. Lloyd, M.P., president of the Associated Chambers of Commerce, a memorial to the following effect was presented to Lord J. Manners:—"That commerce and industry were very much crippled by not having a uniform rate of telegraphing, in the same way as had been adopted with respect to the penny postage. The surcharge on provincial foreign telegrams was a subject much to be deprecated. It was of great importance that her Majesty's Government should enter into arrangements with the contracting powers, by which the cost for inland messages should be made equal to all others. And the association feel persuaded that a uniform rate of 2s. 6d. per twenty words should be adopted." The Postmaster-General replied that he agreed with the spirit of the memorial generally, and thought that the same rates should be charged in the provinces as obtained in London for all foreign telegrams. An assimilation of prices would be proposed at the forthcoming international conference in London, but at present he could not enter into full particulars. The Government was, however, prepared to see a "word" rate introduced, which would, no doubt, have the effect of lowering the prices of telegrams. Although telegrams were cheaper abroad than in England, still foreign governments had not paid so much for their telegraphs as we had, and he did not see how the charge could be reduced in this country. Parliament was very jealous of allowing more money for the telegraph service; but he would see what could be done to meet the views of the deputation.

A NEW American society called the Electrical Society of the Ohio Valley has just been founded at Cincinnatti, and one of its first acts has been to telegraph President Hayes, recommending the appointment of Mr. C. H. Haskins, superintendent of the N. W. Telegraph Company of Milwaukee, as United States' Commissioner

in the Department of Electrical Science to the Paris Exposition.

A CONSIDERABLE quantity of submarine cable has been purchased by the Treasury, and is now stored at Woolwich.

ACTION has been taken by the proprietors of the Bell Telephone against Mr. O'Reilly and Mr. Ladd, instrument makers, for infringement of the telephone patent, which is taken out in the name of Mr. Morgan Brown. Mr. Asten, Q.C. appeared before the Master of the Rolls, in the Chancery Division of the High Court of Justice, and applied for an injunction refraining the defendants from the alleged infringement. The infringement was denied by Mr. Davey, Q.C., and Mr. Cozens Hardy, who represented the defendants. Both cases were allowed to stand over, Mr. O'Reilly's for a week, and Mr. Ladd's for a fortnight, on condition that each of these gentlemen should keep an account.

THE "Bell Telephone Company" in America is about to meet with rivalry in the "American Speaking Telephone" Company, which has been organised by a number of the officers of the Western Union and Gold and Stock Telegraph Companies. The telephone it is proposed to employ is that of Professor Amos E. Dolbear of Tuft's College, the author of the pamphlet on *The Telephone* which has been selling of late in London. Dolbear's telephone has been improved by Mr. Phelps of the Western Union manufactory, having been fitted with a second diaphragm which increases the volume of sound. As improved by Phelps, Dolbear's telephone has been patented, and goes by the name of the Phelps' Duplex Telephone. The Bell Telephone Company it is said, claim this to be an infringement of their patent, and have issued a notice to the effect that the only telephone protected in the United States is that of Professor Bell, and that persons infringing this patent are liable to prosecution for damages. No telephones have been put up as yet by the new company, and some interest is manifested in American electrical circles at the course of procedure the Bell Telephone Company will follow when they are in operation. The rental to be charged by the new company is the same as that established by the Bell Telephone Company, namely, 50 dollars (£10) per annum for a double set of telephones. This charge is considered "somewhat exorbitant" in America.

SOCIETY OF TELEGRAPH ENGINEERS.—Mr. James Allen, telegraph engineer, Buenos Ayres, and superintendent to the Great Southern, Northern, Ensenada and Campana Railways, has accepted the office of hon. secretary and treasurer to this society in the River Plate, in lieu of Mr. Carlos Burton.

A LARGE number of prairie hens are annually killed by striking against the telegraph lines in the Far West.

AUSTRALIAN TELEGRAPHY.—A fine new postal and telegraph office was opened last December at Bathurst, Australia. On the opening day, the Postmaster-General gave the following interesting particulars regarding the Australian Electric Telegraph Department. In 1866, the number of stations was 63; in 1876, 154. In 1866, the extent of wire in operation was 3,346 miles; in 1876, 8,472. During 1866, the number of messages transmitted was 143,523; during 1876, 854,204. For 1866, the total revenue for the department was £30,698 7s. 7d., and the expenditure, exclusive of interest on the cost of construction of lines, £24,506 18s. 9d.; while for 1876, the revenue was £59,384 11s. 6d., and the corresponding expenditure was £69,229 4s. 9d. This increase has been largely due to extension of office hours, and reduction of tariff. The principal country offices are now kept open till 10 p.m.; and a message from Bathurst to Melbourne, which in 1866 cost 6s., now costs only 2s.

IT is proposed to establish two powerful electric lights on the towers of Notre Dame during the Paris Exhibition season. They will operate once or twice a week, and will be turned upon the City, so as to illuminate the principal edifices. The first trials will be made towards the end of April.

APPLICATION OF THE TELEGRAPH TO FLOOD ALARMS.—If the electric telegraph has been advantageously utilised in warning maritime ports of the approach of storms, it may be rendered still more useful in notifying to districts subject to river floods the abnormal rises which take place on the higher reaches, and which are capable of causing incalculable damage if the necessary precautions against them are not taken. We have proof of it in the last great inundations which occurred.

The government (French) having been forewarned in October, 1857, that at Blois, Tours and Angers, a rising of the Loire was expected, which might lead to great disasters, seeing that despatches from the Haut-Allier and the Haut-Loire announced an abnormal elevation of the level of these two rivers, the minister of war sent to Tours and Blois two companies of engineers and two battalions of infantry to direct the works in case of danger, and to maintain order. They despatched at the same time several thousand entrenching tools to increase the resources of the localities. The troops and implements arrived at their destination a considerable time before the flood wave, which appeared at the precise time predicted four days before by the telegraphic despatches. The presence of these auxiliaries was attended by the happiest results.

During these latter years, this service has been well organised in France, thanks to the efforts of two distinguished engineers, M. de Mardigny, engineer-in-chief of the department of the Meuse, and M. Poincaré, their engineer of navigation in the same department, who took the initiative in the matter. To-day, tracts

menaced by inundations can be alarmed a sufficient time beforehand to enable them to take the first and most urgent measures of safety. The Hydrometric Commission of the Rhône and of the Saône, presided over by M. Fournet, has arrived at some remarkable results upon this important and interesting question. We will also cite the labours of M. Belgrand upon the water courses of the north and north-west of France. The inundation of the Seine in 1876, has revealed the services rendered by that engineer. We will instance further the case of the Observatory of the *pic du midi*, which announced several days in advance the frightful floods which ravaged all the basin of the Garonne in 1875.—*Count du Moncel.*

INSULATING GLASS.—A glass jar of a Thomson's Quadrant Electrometer, possessing a high power of insulation, has been analysed by Herr F. Primke (*Dingl. polyt.* I., Vol. 125, p. 174) with the following result:—

SiO_2	K_2O	Na_2O	PbO	CaO	MgO	Fe_2O_3	MnO
58·450	9·236	3·745	28·019	0·064	0·054	0·474	=100·042

Impurities neglected, the composition is as follows:—

SiO_2	K_2O	Na_2O	PbO
58·77	9·28	3·77	28·18=100

PHOTO-ELECTRICITY OF FLUORSPAR.—Herr. W. Hankel (*Ann. de Phys. und Chem.*, Vol. II., 66-83) finding that some crystals of fluorspar from Weardale, Durham, exhibited strong fluorescence and phosphoresence, judged that they might also exhibit electrification on exposure to light. He therefore exposed a crystal to light and found that not only was the crystal electrified but the electrification was much stronger than that exhibited when the same crystal was heated. One experiment was as follows:—A blue violet crystal from Weardale was immersed in copper filings with one face exposed, and kept for some time at a temperature of 95° C. Shortly after it began to cool the face showed an electrification or potential indicated by + 2 divisions on the electrometer employed. On exposing the same crystal to sunshine, the electrification was indicated by — 23 divisions; and on exposing it for two hours to diffused daylight, the electrification was — 1·7 divisions. When, on the other hand, the crystal was exposed to the rays of the sun concentrated upon it by a large lens, it lost its photo-electrical property and did not regain it. Similar results were obtained from three other dark green Weardale crystals. From experiments with coloured glass Herr Hankel concludes that the photo-electricity is due to the so-called chemical rays.

MR. E. GRAVES has been officially appointed engineer-in-chief, and Mr. W. H. Preece, Assistant engineer and electrician, to the Post Office.

DURABILITY OF CABLES.—Mr. Thomas Fuller, managing director of the Black Sea Telegraph Company, writes to us stating that Mons. Lacoine has reported that during the recent repairs of the Constantinople to Odessa cable, the Constantinople to Varna cable of 1854 was hooked, and the portion taken out found to be in perfect condition after twenty-four years' immersion.

WE hear that Messrs. M. Theiler & Sons are making a phonograph which may be used either as a talking machine or as a logograph. The record is in both cases produced upon a ribbon of paper passing between rollers instead of upon a sheet of tinfoil mounted on a grooved cylinder. By this means, the trouble of fixing the sheet of tin-foil and of screwing back the cylinder is entirely avoided. This machine is said to be always ready to talk and to be talked to.

Patents.

719. "Improvements in and appertaining to galvanic cells or batteries."—W. S. WILSON, Feb. 21.

759. "An improvement in the manufacture of telegraph cables."—F. LAMBERT, Feb. 23.

767. "An improved method of covering telegraph wires, wires for electrodes, electro-magnets, galvanoscopes, and others, and also webs of fibrous materials and metals."—N. CONRADI (communicated by R. Wiebe), Feb. 25.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1387. "Electric apparatus for actuating railway brakes."—F. F. A. ACHARD, Paris. Dated April 9, 1877. 6d. This consists in blocking the wheels instantaneously by the employment of electricity, steam, compressed air, or vacuo. In the different arrangements described, the brake lever is lifted by one or more chains, which are wound on a shaft or sleeve receiving a rotary movement from the axle of the vehicle, through the intermediate action of an engaging apparatus. The parts which serve to put the brake in action serve also to effect at the proper moment the engagement of an axle which turns continuously with the shaft or sleeve of the chains. The brake is actuated by electricity, in the manner described in former patents of the author, (1268 of 1862, 3006 of 1864, and 2350 of 1873), and improved so as to stop a train in less than a second if necessary, whatever be the speed of the train and gradient of the way.

1475. "Printing telegraph instruments."—F. H. W. HIGGINS. Dated April 14, 1877. 6d. This consists in a design for a printing telegraph instrument capable of being worked on a single wire without the aid of clockwork for driving the type-wheel. Either one or two type-wheels fixed to a common axis, and driven by a propelment so constructed as to prevent the momentum of the type-wheels carrying them beyond the desired point, are employed as printers. To control the type-wheels there are two pallets, carried by a rocking lever, which act alternately on the top and bottom of a ratchet-wheel on the axis of the type-wheel, and there are pin-stops for the pallets to come against at the end of their forward movement. The armature

which carries the pallets is composed of iron and brass, and is magnetised from a large fixed permanent magnet, through the arbor of which it forms a part. The transmitter sends alternate currents, which by means of electro-magnets effect the printing.

1486. "Galvanic batteries."—E. BLAKEY. Dated April 16, 1877. 2d. This describes a form of Léclanché cell in which the graphite pole takes the form of a partition. *(Not proceeded with.)*

1572. "Gilding."—A. J. DUPUIS and G. O. SCHULZ. Dated April 23, 1877. 2d. This consists in gilding picture frames by coating them first with black lead and electro-gilding them. *(Provisional protection not allowed.)*

1583. "Apparatus for generating electricity."—C. CLAMOND. Dated April 23, 1877. 6d. This consists in improvements in Clamond's thermo-pile, which have been fully described in the TELEGRAPHIC JOURNAL for Feb. 1st.

1598. "Watchman's electric tell-tale and fire-alarm."—W. J. HANCOCK and S. M. YEATES. Dated April 24, 1877. 6d. This consists in a means of testing the faithfulness of a watchman at his post. A pin, wheel, or cam is fixed on the minute-arbor of an ordinary clock; this lifts an arm carrying two contact springs on to a stop fixed in the armature of an electro-magnet, which holds the said arm in position until contact is made by the person in charge. If left in this position longer than the proper time, the cam in revolving makes contact with one of the springs, and shews that the person in charge is defaulting or absent from his post. If the watchman be attending he makes permanent contact, and the cam comes into contact with the other spring, thereby causing an alarm bell to sound and notifying the fact. The patent also provides for signals being sent from a number of stations or compartments to a central one, by means of a small shaft fitted with a corresponding number of cams and contact springs; an indicator being fixed in circuit with each.

1599. "Electric telegraph apparatus." G. T. PATERSON. Dated April 24, 1877. 2d. This is intended to produce a perfect block system of signalling, so that when a signal indicating the passage of a train has been forwarded to the next station on the line, and the sending apparatus has been blocked, no other signal can be forwarded until the first signal has been acknowledged from the next station. This is effected by attaching to the sending station signalling instrument a spring bolt, which is pushed under the "tapper" when the signal has been made so as to prevent the "tapper" descending, unless the return signal is made. *(Not proceeded with.)*

1602. "Telegraphic discs or signalling apparatus."—URSIN JUSTON, Paris, dated April 25, 1877. 1s. 2d. This consists in a method of controlling a telegraph or signal disc by means of electricity so that the disc is shown or not from a signal post. The disc is retained in its out-of-sight position by mechanism which can be actuated by electro-magnetism, so as to free the disc, upon which the latter mounts to the top of the post, by a counterpoise, into its visible position. The disc is a square plate of sheet iron, and carries a ring on which the retaining apparatus takes hold. The current by actuating the electro-magnet of the retaining apparatus frees this ring, and allows the disc to rise into view. The disc is lowered again and set in its retained position by an attendant. This system is designed for application to railways, in order to prevent collisions of trains. A disc should be placed at each curve of the line so that the engine-driver can see from one disc to the next. The disc is controlled by the departure and arrival stations. A line wire is necessary to put all the discs in simultaneous motion, whatever be the distance, so that all the station-masters may always know the position of the trains which are travelling.

1640. "Chemical telegraphs."—C. A. RANDALL and T. M. FOOTE, New York, U.S., dated April 26, 1877. 10d. This consists in a method of transmitting signals electro-chemically over a single wire, and printing the message in Roman letters, a letter being obtained at each electric impulse. This is done by having two type-wheels, one at the sending and one at the receiving station, turning isochronously. A strip of chemically prepared paper passes between the marking style or pen, and the type-wheel of the receiver, so that the current from the sending station in passing from the style to the type-wheel decomposes the chemical preparation at the points where the type touches the paper, and thereby produces an exact fac-simile of the letter.

TRAFFIC RECEIPTS.

Name of Co., with amount of capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £90,000.	Cuba Sub. Co. £16,000.	Direct Spanish Co. £13,000.	Direct U.S. Co. £65,000.	Eastern Co. £369,700.	Eastern Ex. Co. £199,750.	Gt. Northern Co. £125,000.	Indo-Euro. Co. £17,000.	Submarine Co. £338,225.	West Coast America Co. £300,000.	Western and Brazilian Co. £69,910.	West India Co. £88,320.
	£	£	£	£	£	£	£	£	£	£	£	£	£
February, 1878...	43,470	9,671	*2,800	814	10,010	41,831	20,716	12,725	... ...	9,257	1,425	7,721	*5,034
February, 1877 ...	32,290	11,725	2,214	784	15,520	35,050	19,645	12,800	... ...	8,624	2,980	11,343	3,870
†Total Inc. 1878	23,340	... ...	1,275	23	... ...	5,732	... ...	508	... ...	586	... ...	... ...	2,306
†Total Dec., 1878	... ...	1,754	... ...	... ...	5,310	... ...	171	... ...	... ...	... ...	2,263	3,545	... ...

* Estimated. † Compared with same period 1877.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness.)

Correspondence.

ON THE RESULTANT FAULT.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Some years ago it was proved that in taking the loop-earth-test the same result would be obtained, in any particular case, if all the leakages were replaced by a single leakage having a resistance equal to the true insulation resistance, and existing at the centre of gravity of the conductivities of all the leakages. Recently Professors Ayrton and Perry have investigated in their paper on "The resultant fault in the conduction, insulation, and circuit tests," whether the same substitution could be effected in the three tests just mentioned, and they found that the error so made in the conduction test was very small, in the insulation test that it was a little larger, and in the circuit test (or test of the line put to earth through the receiving instrument) that it was still larger, being, however, in all three cases very small, provided the ratio of the true wire resistance of the whole line to the square root of the insulation resistance of a length of line having unit wire resistance was considerable. The method of reasoning they employed in obtaining these results was applicable in all cases when the insulation resistance at any point of the line was such a function, $f(\rho)$, of the wire resistance, l, up to that point that the differential equation

$$f(\rho)\frac{d^2v}{dl^2} = v$$

could be integrated, so that v, the potential of that point, could be found.

Starting with the assumption that this substitution of a resultant fault could be legitimately made in the conduction insulation and circuit tests when the insulation of the line was uniform, Mr. Schwendler, some time ago, developed formulæ for ascertaining "the corrected or true conduction and insulation resistances," and also a formula for calculating the resistance of the distant receiving instrument, the result obtained by which, being compared with the known resistance, serves as a check in deciding whether or not the insulation of the line is uniform, *i.e.*, in fact, whether or not Mr. Schwendler's formulæ for the corrected conduction and insulation resistances can or cannot be used, and also which gives an indication of the kind, but *not* of the magnitude, of the error made by using them when the resultant fault is not in the electrical centre of the line. But I am not aware that any simple formulæ have been published for determining the true wire and insulation resistances, independently of the position of the resultant fault. Now Professors Ayrton and Perry have suggested to me that M. Blavier's well-known formulæ would enable us to do this if the true wire resistance of the line, which, in M. Blavier's equations, is always assumed to be previously known, were regarded as an unknown quantity, and the distance up to the fault, which is also unknown, were eliminated by combining with the usual conduction and insulation tests one other—the circuit test—or test when the receiving instrument, of known resistance, is inserted in the line at the distant station. Consequently I have worked out the following equations, which are so simple in their application, that attention need only be drawn to them to show their practical utility.

Let w be the true wire, and u the true insulation resistance of a line; x the wire resistance up to the resultant fault; c, s, i, the resistances obtained when taking the conduction circuit and insulation tests, and r, the known resistance of the receiving instrument at the distant station: then it may be easily proved that

$$w = \frac{r(i-s) + i(s-c)}{s-c} - 2\sqrt{\frac{r(i-c)(i-s)}{s-c}}$$

$$u = \sqrt{\frac{r(i-c)(i-s)}{s-c}}$$

$$x = i - \sqrt{\frac{r(i-c)(i-s)}{s-c}}$$

For by M. Blavier's equations we have, if y is the wire resistance from the resultant fault up to the distant station,

$$x = c\sqrt{(i-c)(w-c)}$$

$$y = (w-c) + \sqrt{(i-c)(w-c)}$$

$$u = (i-c) + \sqrt{(i-c)(w-c)}$$

(*See* Clark and Sabine's Electrical Tables, *page* 47.)

Also in a similar way it may be shown that

$$x = s - \sqrt{(i-s)(w+r-c)}$$

and from these four equations y can be eliminated, and w, u, and x found, obtaining the results given above.

I beg to remain, Sir,
Very truly yours,
T. IWATA,
Telegraph Engineering Student.

The Physical Laboratory,
The Imperial College of Engineering,
Tokio, Japan.

To the Editor of THE TELEGRAPHIC JOURNAL.

MY DEAR SIR,—It may be interesting to inform the readers of your valuable journal that a very satisfactory telephonic conversation has taken place between "Persia and Russia." The officiating gentlemen were Mr. C. Taplin, of Cardiff, now in the Indo-European Telegraph Company's service, at Tabreez, and Mr. F. E. Gibbins, of the same Company, at Tiflis. About midnight, when all was quiet and traffic ceased, a telephone was fixed at each end of the wire, and a conversation, besides some vocal music, took place at the very long distance of 390 miles. The weather was very fine throughout the line, with a sharp frost after a fall of snow at Tabreez.

Owing to the commencement of despatches on the Russian wire (which line runs parallel to that of the Indo) in Armenia, induction put a stop to the wonderful conversation, so the gentlemen wound up by exchanging the National Anthem of old England.

The telephone used at Tiflis was made by Messrs. Siemens and Halske, and that at Tabreez (the first in the country) by Mr. C. Taplin himself, to whom great credit is due for making so delicate and sensitive an apparatus, whilst so badly provided with materials, &c.

Trusting to your kindness for the insertion of the above in your journal,

I remain, dear Sir,
Yours very truly,
HILDND. F. STEVENS.

Persia, Tabreez,
February 20th, 1878.

To the Editor of THE TELEGRAPHIC JOURNAL.

DEAR SIR,—Your journal of the 15th February, 1878, contained the translation of a paragraph from *Count du Moncel*, relative to the application of the telegraph to the herring fishery in Norway.

The substance of this quotation was printed in *Nature* of 28th February, but without acknowledgment either of copying it from the TELEGRAPHIC JOURNAL, or from *Count du Moncel;* and, quoting from *Nature*, I observe, *The Times*, on March 1st, 1878, reprints the same thing; and, like *Nature*, commences thus, "A novel use of the telegraph has lately been adopted by the Norwegian Government."

It would therefore appear that it is not generally known that the paragraph, of which you gave the translation, occurs in Count du Moncel's "Traité théorique et pratique du Telégraphie Electrique," which was printed at Paris in 1864, and that this application of the telegraph is by no means so new a thing that it may be said to have been "lately adopted by the Nowegian Government."

If these "200 kilometres" of cable are still in working order, having been repaired or renewed as required from time to time, according to the ordinary necessities of submarine cables, no doubt they render as good service now, as they did when first established, *at least fourteen years ago.*

How many years are to be added to these fourteen I am unable to say.

JAS. GRAVES.

Valentia, March 9th, 1878.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—The article alluded to as accrediting Mr. Paul with the gelatine transfer negative process and alluded to by Messrs. Wratten and Wainwright in your issue for February 15th, was perfectly well known to me, and as far as priority of publication goes Mr. Paul certainly has the lead. However, I do not see how the case I alluded to is altered. Why did not Messrs. W. & W., who evidently knew that the process was anothers, not mention the fact, their article distinctly conveying the impression that the process was part of *their* new system of Photography.

What the 11th commandment is I do not know, therefore I am unaware of the principle on which I should drop my claims, which are as follows:

On the day that the article was published in the British Journal, I was crossing Mont Cenis on my return from Italy with some 40 or 50 transferred negatives, lying between the leaves of a book in my portmanteau. These were taken and transferred at different times between the latter part of January and the beginning of May, on the fifth day of which latter month the article appeared. Such is my claim, which can easily be substantiated by gentlemen residing in Naples.

Yours obediently,

WALTER B. WOODBURY.

South Norwood,
March 7th, 1878.

Proceedings of Societies.

SOCIETY OF TELEGRAPH ENGINEERS.

(*Continued from page* 101.)

ACROSS the Hudson and its branch, the East River, at New York, are several cables, made up of seven conductors, and weighing about eight tons to the mile. As they lie right across the anchorage grounds they are continually being fouled by ships' anchors, in some cases, five or six times a day. The Western Union Co., therefore, keep a tug with steam up always ready to run out and assist to clear or repair the cables.

Some very smart work is sometimes done in this way. Messrs. Preece and Fischer were present on one occasion when a mile and a quarter of cable in fourteen fathoms was picked up in forty minutes. It was then repaired and carried to another part of the river, where it was laid out in *six* minutes.

The land lines are as sound and good as any of our own. Poles average twenty five feet high, and six inches diameter at top, and are mostly of red or white cedar. They cost from half a dollar to one dollar each, and last twelve to twenty years. In many places chestnut, which in America grows very straight, is employed; cypress and other woods elsewhere, according to locality. In England, our poles if unpreserved, last only seven or eight years, but the climate of America is so much drier that wood lasts longer. It is also cheaper, and therefore no preserving processes are employed, nor are iron poles used. Arms are generally of white pine; for two wires their length is three feet, four wires five feet six inches, six wires seven feet six inches. The wire is sometimes ungalvanised, but the use of ungalvanised wire is dying out, and in future, most of the wire will be galvanised. Numbers six, eight, and nine, are the gauges in use, number six being principally used for long distances.

To America is due the credit of introducing electrical tests for conductivity of iron wire, a practice which is now coming into use in England and elsewhere. They have also employed experimentally a copper covered iron wire, produced by lapping a copper tape round the wire, or by electro-plating it. Although no great results have as yet been attained, the experiments seem to hold out a hope that we may shortly be in possession of a wire, which, with the lightness of number sixteen shall possess the strength of number eight and the conductivity of number four.

The wires are not pulled up so tight as ours, the relative strains being about 200 lbs. to 300 lbs., but our arms are closer together. The Britannia joint, universally employed here, is not used in America, but a curious and complex twisted joint is made, and is dipped into a bath of solder. Formerly joints were not soldered, and even to this day they do not solder their joints in Canada. As a striking proof of the advantage of soldering, Mr. Preece mentioned that a line which before soldering gave a resistance as high as 23,500 ohms, fell to 1,400 after being soldered.

Throughout the vast system of the Western Union Company only one kind of insulator is used, viz., an annealed green glass one, which answers well in an American atmosphere, but which was long ago given up as useless in England. The insulators are made to screw on to wooden pegs, or brackets, and are easily and rapidly fixed. The wire is not bound in as with us, but one turn of No. 8 or 9 only being used as a tie wire. No shackles are employed, scarcely any stays or struts, and but few earth-wires. With us earth-wires, originally introduced as lightning protectors, are valuable as safe-guards against weather-contact. This is a difficulty with which the Americans are not much troubled. They get very heavy thunderstorms, yet they suffer less from lightning than we do, their lines being scattered over such vast spaces of country instead of being concentrated over a small area as in England. When a line is struck, however, it is sometimes a serious affair, as many as 200 poles having been destroyed at one time.

The lines are well and efficiently maintained, breakdowns being about as frequent as with us, and taking about the same time to repair. The responsibility of removing faults rests with the operating staff. Every manager of an office is responsible for the condition of the apparatus, and the chief operator does the testing,

such as it is. Few galvanometers are seen in the offices, the locality of a break being estimated by receiving the return shock on the fingers! There is an official called a repairer, who is a sort of cross between our "lineman" and our "inspector," who does the renewals, and who is paid from £150 to £200 per annum.

Closed circuits have been and still are the favourite system of working, although they are gradually giving place to open circuits, especially for long distances. They have the advantage of the batteries being all in one place; but the substitution of the open circuit effects a saving in battery power.

As regards instruments, the sounder is most generally used. Mr. Preece exhibited a few neat specimens, and spoke very highly in favour of the sounder, the use of which he has advocated for some years past. All the apparatus required to rig up an American office are a key, a relay, and a small sounder. On long circuits repeaters are used, the principal or "relay" stations being provided with several of them. In fine weather some of these can be cut out, but in bad weather have to be resorted to. Mr. Preece mentioned a remarkable fact, that no apparent loss of speed resulted from their employment. This is, of course, in direct variance with our experience here.

Compound or multiplex telegraphy is largely adopted in the States, the duplex, quadruplex, and various other "plexes" of Stearns, Edison, Prescott, Gray, and others, all coming in for a share of favour in telegraphic circles. It may be mentioned here that the quadruplex system as established on the London-Liverpool circuit by Messrs. Smith and Hamilton, who recently visited this country for that purpose, is in daily operation, and gives highly satisfactory results.

Type-printers are employed to some extent, principally the form elaborated by Mr. Phelps, on the basis of that invented many years since by Professor Hughes. They are, however, chiefly confined to private wires.

Edison's automatic system is used by the Atlantic and Pacific Company, and very flattering accounts of its performance are recorded. The maximum speed witnessed by Mr. Preece did not exceed 200 words per minute.

On the Chicago and Dubuque circuit there is a terminal telephonic circuit, in which through communication is carried on without interfering with the Morse working. The telephone, however, does not seem to play any great part, as yet, in commercial telegraphy.

In concluding his remarks upon the telegraph companies, Mr. Preece mentioned that he visited some of the workshops, and was surprised to find how few mechanics are employed. Much of the work which in England provides occupation for gangs of mechanics, in America is done by the operators, who, as before-mentioned, are very skilful.

Some curious and characteristic terms are current in America, and Mr. Preece highly amused his audience by repeating a few of them. Thus, an operator is called a "plug;" to stop is to "break;" calling a station is "raising" it; contact is "cross-fire," &c.

One of the most efficient services in America is the fire-telegraph system, and, withal, one of the most important in a country where so much wood is used in building. In every town a most complete and perfect system of fire signals has been established. When a fire is observed, the alarmist has only to pull a handle or do something equally simple; this rings a bell at the fire-station and indicates the locality of the fire, so that in most cases fires are mastered before they can get head-way. The effect of this system has been to render the American fire brigades expert to a degree which is quite incomprehensible to us. Mr. Preece states that he and Mr. Fischer, when inspecting the working of the system, timed the operation of getting an engine out and away. A gong was sounded, the same current which gave the signal serving to release the horses, who, trained to their work, moved mechanically to their places at the engine; the men jumped up and away they went. The mean of three observations gave 8 seconds as the time elapsed from the sounding of the alarm to the starting of the engine. Mr. Preece also testified to a still more perfect state of things as existing at Chicago. There the signal-current not only sounds the gong and unhitches the horses, but it also draws the bolts from a series of trap-doors; and, that nothing may be left undone, it whips the clothes off the men whose beds are so placed with regard to the trap-doors that they are gently slid down into their places ready for a start! (It was not stated whether the men turn in with their uniform on, or whether the current puts this on for them).

But even this close approach to automatism is not left unsurpassed; for many buildings are provided with automatic alarms which upon any abnormal increase of temperature close a circuit and "sound an alarm."

Domestic comfort is studied and ministered to in a variety of ways. Compact, and not unsightly, little boxes are fixed up in a convenient place in the house. This box has a dial divided into compartments headed, respectively, messenger, doctor, cab, &c., and a pointer which can be set to any of these compartments. By simply pressing a lever, the person's wants are at once made known at the nearest call-station, as also the house from which the call proceeded, and in the briefest possible time the required person or article puts in an appearance.

With regard to the general question of the organisation of the staff, the American telegraph system is characterised by far greater elasticity than ours, more being left to the discretion and *savoir faire* of the officials than is the case with us. The result cannot fail to be beneficial to the service; each man knows that his success in life depends upon the aptitude and administrative capacity displayed by him; a wholesome spirit of emulation is thereby established, and there is, consequently, far less of that half-hearted service which too frequently characterises the English *employé*.

Financially considered, the American telegraphs are a greater success than the English; they "pay" better. It must be remembered, however, that they are still in the possession of joint stock companies, and that, therefore, unimportant places are left out in the cold, only those places which can offer a fair amount of traffic being served. In England the system has been enormously developed, since its acquisition by the Post Office, upon principles of national utility rather than with an eye to large revenues.

In view of these and other considerations, Mr. Preece would not attempt any close comparison between the two systems: each is admirable in its own way, and neither can be said to be in advance of the other. In America the carrying capacity of the wires has been increased by the introduction of multiplex working; in England the same end has been sought, and to a great extent attained, by the perfecting of fast speed instruments, such as the Wheatstone automatic, &c.

In the matter of invention there are some notable points of difference between the two countries, and the comparison is apparently unfavourable to us. Here, it is the fashion to keep an invention secret, and an inventor has to rely principally upon his own private resources. In America, invention is subsidised—in fact, men are paid to invent. Mr. Edison, one of the most eminent electricians of the day, is retained by the Western Union Co., and furnished with a magnificent, well-

appointed, experimental laboratory for the sole purpose of inventing. It is needless to point out that Mr. Edison's labours have not been unfruitful. In America, too, if a man hits upon a happy idea, it is taken up, and he is assisted to put it into practical shape. These facts were adduced by Mr. Preece as an appropriate answer to those pessimists who complain that we stand with our hands in our pockets waiting to take our "cue" from America. Perhaps it may also be regarded by some as an argument in favour of the "endowment of research," so much talked of now-a-days.

At the conclusion of the lecture, which was illustrated by diagrams and by the exhibition of some representative instruments, insulators, and other objects employed in America, a cordial vote of thanks to Mr. Preece, for his able and entertaining discourse, was moved by Sir Chas. Bright, and seconded by Professor Hughes, and carried by acclamation.

THE INSTITUTION OF CIVIL ENGINEERS.

AT the meeting on Tuesday, the 26th of February, Mr. W. H. BARLOW, Vice-President, in the chair, the Paper read was on "Liquid Fuels," by Mr. H. Aydon.

It was stated that apparatus specifically adapted for the combustion of liquid fuels, which comprised every class of fluid hydro-carbons, might be ranged in five classes. The leading principle of their action was either the subdivision of the liquid as spray, or by percolation through a porus bed, or by preliminary conversion into vapour,—when the fuel was mixed with air, or with air and steam, by the instrumentality of jets of steam or of compressed air, or it was burned simply as gas in jets. The earlier system of Mr. C. J. Richardson, in which the liquid fuel, mixed with heated air, percolated upwards through a porous bed, was tried at Woolwich Dockyard, but the performance was not satisfactory, for black smoke and soot were discharged in such abundance as speedily to choke the flue-tubes and stifle the draught. By a subsequent improvement, in which a mixture of steam was introduced with the fuel, a much better performance was effected—the quantity of water evaporated having been increased from 6¾lbs. per lb. of fuel to from 7 lbs. to 18½ lbs. per lb. of fuel, though the formation of dense smoke was not prevented. The performance of coal under the same boiler amounted to an evaporation of 8 lbs. of water per lb. of coal.

The system of Messrs. Simm and Barff, in which the liquid fuel was vaporised in a retort placed in the furnace, and burned in jets, was tried in 1866, on board the yacht "Minnie." The quantity of oil consumed amounted to one-third only of the corresponding quantity of coal. The system was afterwards tried with the addition of steam, and with better results, as the intensity of the combustion was increased, and smoke was prevented.

In the fourth system, patented by the author, in conjunction with Mr. Wise and Mr. Field, in 1865, the liquid fuel was summarily vaporised, by the injection of the liquid into the furnace by the instrumentality of steam, which might be superheated, the supply of air for combustion being at the same time drawn in as an induced current. By this plan, the materials could be instantly and thoroughly mixed and converted into vapour or gas before ignition took place. No alteration of the ordinary furnace or grate was needed, so that either coal or oil could be used. For burning oil, the grate-bars were covered with thin fire slabs and a few cinders; and the ash-pit doors were closed, to keep out surplus air. In March, 1867, this method of burning liquid fuel was tried at the works of Messrs. J. C. and J. Field, South Lambeth, in a Cornish boiler. The results of several days' experiments showed an average of 19½ lbs. of water evaporated per lb. of liquid fuel. The boiler previously evaporated 6½ lbs. of water per lb. of Aberdare coal. Similarly, experiments with a double-flue Galloway boiler, at the chemical works of Mr. Barnes, at Hackney Wick, gave a net evaporative performance of 25·3 lbs. of water per lb. of fuel. Experiments had been made with other boilers, in which the evaporative efficiency of the liquid fuel ranged from 1½ to 3 times that of coal. Equally good results in favour of liquid fuel were obtained from its employment under a marine boiler at Woolwich Dockyard.

The fifth system enumerated, the invention of Mr. Dorsett, in which the liquid fuel was vaporised in a separate boiler or retort, to be burned as a gas, was tried in 1868, at the chemical works of the inventor, at Deptford, and also on board the "Retriever" steamer. The results in favour of liquid fuel showed a reduced consumption in the ratio of 2·5 or 2·7 to 1 as compared with coal; but against this economy had to be placed the cost of the separate generators and their furnaces, and of a force-pump. The retort, too, was liable to explosion, in consequence of the deposit of solid carbon within it.

The first employment of the author's system in metallurgical operations was at the Millwall Iron Works. The oil furnace was an adaptation of an old scrap iron furnace. It was fitted with bricks, and was used as a combustion chamber. Three oil injectors played directly upon the metal to be heated, lengthwise of the furnace.

The furnace consumed 6,720 lbs. of coal in twelve hours to keep up the heat, against 1,405 lbs. of liquid fuel, showing a ratio of 4¾ to 1 in favour of the oil, the consumption of which was at the rate of 17 lbs. per cwt. of iron. The loss of iron treated by coal was from 22 to 25 per cent., whereas with liquid fuel it was only 11½ per cent. by system 4, and 16½ per cent. by system 5.

The author, in 1875, proceeded to Canada, to experiment on the reduction and smelting of the refractory iron ores of that country, many of which were magnetic, and contained 32 per cent. of titanic sand. The experiments proved satisfactory, and pig iron was readily produced from the ore; though it was found that oil-fuel in smelting operations must be used in connection with an air-blast under pressure.

In the discussion on Mr. Aydon's paper, Admiral Selwyn advocated the use of oil as fuel specially on the ground of its applicability to vessels of the Royal Navy, which could now only store sufficient coal for three days' consumption at full speed, but that in the same space enough oil could be stored for nine days, an invaluable gain when in pursuit of an enemy. He remarked that oil was the only fuel which gave almost the full calorific result which theory would indicate, whereas with coal the loss was considerable. He also said that the heat produced by oil was so great, that the steam serving to inject the oil was decomposed into its constituents hydrogen and oxygen, the oxygen uniting with the carbon in the oil forming carbonic oxide, causing the heating effects to be somewhat greater than that due to the combustion of the oil less the loss of gas passing up the chimney. He looked to the mineral oils as the fuel of the future. Another speaker considered that oil was not at all cheaper than coal, and that it would be very dangerous in the hold of a vessel. He and a subsequent speaker considered the notion of steam affording additional heat was untenable. Mr. Crampton observed that the difference

in calorific effect between coal and petroleum, being about as 13 to 17, was so small as to give the oil only a slight advantage; that the use of oil was objectionable for sound reasons, and that the amount available was so small that if any considerable demand arose for it, the price would rise to such an extent as to make it much dearer than coal. Mr. Aydon, in reply, said that creosote was obtainable at one half-penny per gallon, and that he had got oil at one farthing per gallon; that mineral oils were found in most parts of the world, but that the chief value of oil as fuel was the small space it occupied.

AT the meeting on Tuesday, the 5th of March, Mr. BATEMAN, President, in the chair, the Paper read was on "The Hooghly Floating Bridge," by Mr. Bradford Leslie, M. Inst. C.E.

This bridge connected Calcutta on the left with Howrah on the right bank of the Hooghly, at a short distance north of the East Indian Railway terminus. Various projects had been from time to time proposed; but ultimately the preference was given to a floating bridge, as it could be more cheaply and expeditiously constructed than a fixed bridge. The design was prepared in 1868, when it was intended to be carried out by a joint stock company; but after much delay, in 1872 it was undertaken through the agency of the Local Government of Bengal. The work was commenced in January 1873, and the bridge was opened for traffic in October 1874.

The present structure was the first, and, up to this date the only one of its kind affording headway for river navigation. It divided the port into two sections. The lower part was occupied by sea-going ships and steamers, and the upper part by inland craft and a few coasting vessels. As, however, the graving docks were above bridge, it was necessary that an opening should be provided for the passage of shipping. The extreme rise and fall of the tide during floods was 20 feet, and at certain seasons there was a tidal wave 6 feet in height. The maximum velocity of the stream was 6 miles an hour. The depth of the river at the site of the bridge was variable, the greatest depth at low water being 6 fathoms.

The bridge was 1,530 feet long between the abutments, and the roadway was 48 feet wide, with footpaths each 7 feet in width on both sides, so that the total width of the platform was 62 feet. There were four main longitudinal wrought-iron girders, at intervals of 16 feet in the width of the roadway, raised by timber trusses, resting upon pontoons, to a convenient height above the water for accommodating the boat navigation. The platform of the bridge was level for a distance of 384 feet on each side of the centre, at a height of 27 feet above the water. Thence it fell by inclines of 1 in 40 to a distance of 584 feet on each side of the centre line, where there was a length of 20 feet of level platform 22 feet above the water. Between these points and the abutments were the adjusting ways, the shore ends of which were 32 feet above low water. The approach on the adjusting ways was by a descent of 1 in 16 at extreme low water, and by a corresponding ascent at extreme high water; but at ordinary times it was either level, or only slightly inclined. The platforms of the adjusting ways were supported on the lower flanges of three bowstring girders, the roadway being divided into two by the centre girder. The footpaths were carried on cantilevers riveted to the outer girders. The bowstring girders were 160 feet long between the end pins on which they were hinged. The outer floating ends were hinged to pivot bearings, in order to admit of a slight drift up and down stream.

The floating portion of the bridge was carried on twenty-eight pontoons, coupled together in pairs to secure stability. With the exception of the two pairs in the centre, which supported the movable sections of the bridge, each pair carried 100 feet in length of the platform. Each pair was coupled together, at a maximum distance of 48 feet from centre to centre, by four timber cills bolted to the decks of the pontoons at intervals of 16 feet. These cills constituted the bottom members of the four main longitudinal trusses, the top members being the wrought-iron girders, carrying the roadway. With the exception of the upper girders, the whole of these trusses were of teak. The coupled pontoons were further connected by strong horizontal diagonal bracing of bar iron. The timber cills and the bracing being only four feet above the water, the space between the coupled pontoons was not available for navigation, and floating fenders or booms were provided to divert boats from these openings. Ordinarily the main girders overhung the pontoons 21 feet, their ends being supported by the inclined struts of the trusses, leaving a width for navigation of 42 feet, partially obstructed by the raking struts. For the convenience of the country craft, there were two rectangular openings of 60 feet clear span between the fourth and the fifth pairs of pontoons, reckoning from each abutment. The roadway over these openings was carried on eight girders.

All the pontoons were 160 feet long, by 10 feet beam, with holds varying from 8 to 11 feet in depth, according to the dead weight to be carried. Each pontoon, excepting those of the movable sections, was accurately anchored by permanent moorings, laid exactly in line with the centre of the pontoon, the distance between the up and the down stream anchors being 900 feet. The strain on the chain cables varied from 5 to 25 tons; their great length afforded the necesary "spring," to allow for the rise and fall of the tide, but a few links were taken in during the dry season, and slacked out again during the flood season.

The 200 feet opening for the passage of ships was one of the most difficult problems in designing the bridge. Owing to the strength and irregular set of the stream and eddies, ships could only be moved at or near slack tide; and it was a rule that all vessels of more than 200 tons must be moved by steam against the tide. The bridge was generally opened twice a week at high water, but occasionally at low water. The opening was effected by removing the two centre sections of the bridge bodily. These sections were connected with the fixed portions of the bridge by drawbridges, which on being run back left a clearance of 20 feet on each side of the platform of the movable sections. By means of steel warps, laid to buoys moored for the purpose, these sections were warped up stream far enough to clear the rest of the bridge. They were then disconnected and sheared over, one on each side, leaving a fair way clear of all obstructions. The bridge was closed by reversing these proceedings. The ordinary time taken in opening the bridge was fifteen minutes, and in closing it twenty minutes.

There was a daily traffic of about 6,000 tons of heavy goods, which were conveyed in bullock carts, besides foot and carriage passengers.

An accident delayed the completion of the work about three months. This arose from a deeply-laden ship fouling two vessels, which parted from their moorings, and both were sent up stream on the top of the "bore" at the rate of 5 knots an hour. One vessel went through the centre opening, but the other struck the bridge, causing three pontoons to be sunk, and the superstructure to be completely wrecked.

In the discussion which followed, some difference of

opinion was expressed with reference to the choice of a floating bridge in preference to a fixed one. It was stated that some proposals had been recently made for erecting a fixed bridge rather higher up the river, at a cost of about £200,000, which was mentioned as about the cost of the floating bridge. Some floating bridges erected in the United States and Canada were referred to; but the only instance given of a floating bridge, in which the platform was raised to any extent above the water, like the Hooghly bridge, was a bridge at St. Petersburg. The advantages possessed by a floating bridge, in being easily repaired if damaged by vessels drifting against it in a cyclone, were pointed out; and also the peculiarly unstable nature of the bed of the Hooghly, rendering it uncertain to what depth it might be necessary to carry down the foundations for a fixed bridge. The gentleman who, in Mr. Leslie's absence, replied to the objections raised, stated that the Government had objected to the erection of a fixed bridge, and endorsed the remarks made by other speakers, that a fixed bridge could not be erected on such a site at a less cost than £600,000. In answer to some remarks made about the insecurity of the moorings, he said that the anchors tended to sink in the silt, and had occasionally to be lifted. The bridge had efficiently, and in a short time, supplied a pressing want, and if at any time a fixed bridge was built, the present bridge could be shifted to another place.

PHYSICAL SOCIETY.—MARCH 2nd, 1878.

Professor W. G. ADAMS, President, in the chair.

THE following candidates were elected members of the society:—Mr. J. P. Kirhman and Dr. W. J. Russell, F.R.S.

Mr. SEDLEY TAYLOR exhibited the colours produced in thin films by sonorous vibrations. A piece of thin brass perforated with a triangular, circular, or rectangular aperture, and bearing a thin film of soap solution, was placed horizontally on one end of an L shaped tube; the beam of the electric lamp, after reflection from it, was received on a screen. It was shown that when a sound is emitted in the neighbourhood of the open end of the tube, the film takes up a regular form, which is indicated by the different colours of the reflected light, and each note has its own particular colour figure; and further, with different instruments we have different figures. Thus, when a square film was employed, a kind of coloured grating was the result, which was modified by changing the note, and with a circular film concentric rings traversed by two bars at right angles were observed.

Mr. W. H. PREECE exhibited and described the phonograph. After referring to the manner in which the preceding communication bore on the subject of the telephone, he went on to explain the construction of the two instruments exhibited, which have been made in accordance with the published accounts of the apparatus, and details received from the inventor, Mr. T. A. Edison, by Mr. Pidgeon and Mr. Stroh respectively. In the first of these the receiving and emitting discs are distinct, the former being of ferrotype iron, and the latter of paper, whereas in the second form of apparatus, both these functions are performed by one and the same disc of iron. They also differ in that, in Mr. Pidgeon's apparatus, the drum receives its motion by hand, and in that of Mr. Stroh a descending weight is caused to communicate motion by a suitable train of wheels, which motion can be controlled and regulated by an adjustable pair of vanes. In both cases the drum is of brass, traced over by a spiral groove, and the whole is mounted on a screw of the same pitch. The manner of using the phonograph is extremely simple. The drum having been covered with tin foil, a uniform movement of rotation is given to it, and a fine metal point, firmly fixed to the centre of the receiving plate is brought in contact with it, care being taken to place the point accurately over the groove. If now this plate be sung or spoken to, the tinfoil will be indented in accordance with the vibrations communicated to the plate. The emitting plate having been provided with a resonator, its point is now brought into the position initially occupied by the point of the receiving plate, and, on rotating the drum with the same velocity, fairly identical sounds are given out. It will be seen that Mr. Stroh's apparatus has an advantage over that of Mr. Pidgeon in that it secures a constant rate of rotation; but, on the other hand, the sounds emitted by the paper disc appeared to be more distinct than those from the iron. A number of experiments were performed with the instruments. The sounds were reproduced at times with remarkable distinctness, and when Mr. Spagnoletti and Mr. Sedley Taylor sang "God Save the Queen," as a duet, through a double mouthpiece, the two voices could be clearly distinguished on its being reproduced. It was shown that even when an indented sheet of tinfoil has been employed to emit sounds, it retains its form with such perfectness, that the sounds can be reproduced by means of it a second and even a third time with nearly equal distinctness.

Prof. GRAHAM BELL pointed out that the articulation of the instruments was very similar to what he had observed in the earlier forms of telephone, and he had no doubt, judging from his own experience of that instrument, that the phonograph will ere long be so adjusted as to articulate much more perfectly. He anticipated that the *quality* of the sound would be found to vary as the rate of rotation was altered, as well as the pitch, and this proved on experiment to be the case.

THE METEOROLOGICAL SOCIETY.

THE usual monthly meeting of this Society was held on Wednesday, the 20th inst., at the Institution of Civil Engineers, Mr. C. Greaves, F.G.S., President, in the chair, when Dr. Tripe read a Paper on "The Winter Climate of some English Sea-side Health Resorts." The places selected were Scilly, Torquay, Penzance, Guernsey, Barnstaple, Ventnor, Llandudno, Ramsgate, and Hastings, and the climatic features of each were compared with those of London. The results of this discussion may be briefly summed up as follows, viz:—The mean daily winter temperature of these seaside places, and especially of those situated on the coast of Devon and Scilly, is higher than at London; the mean daily maxima and minima are also higher, and especially the latter, so that the daily and monthly ranges of temperature are smaller; the mean humidity is less; the general direction of the wind about the same, but the number of rainy days and the rainfall are greater at the sea-side. As regards the wind, therefore, the chief point to be especially noticed is the amount of shelter afforded by high land, as at Ventnor, and especially of protection against the stormy and cold winds which ordinarily prevail at the end of February and in March. The soil also should be considered, as heavy rains at gravelly and chalky places are not so objectionable as on clayey ground. The discussion on this paper was adjourned until the next meeting which will be held on March 20th.

General Science Columns.

THE TAY BRIDGE.

EARLY in the year 1871, the necessities of the traffic on the North British Railway, made it evident that the ferries over the Firths of Forth and Tay were unequal to the conveyance of the traffic on that great main railway artery of Scotland. The same year saw the commencement of the Tay Bridge, and a scheme for a Firth of Forth Bridge has since that date been successfully carried through Parliament by the North British Railway Company. The Tay Bridge, which forms a portion of the new branch railway from Leuchars, on the Fife line to Dundee, consists of a bridge almost two miles in length, over a rapid tidal river, having a bottom chiefly formed by alluvial deposit. The original design of the bridge comprised 89 spans of varying lengths, six of 28 feet, twenty-five of 66 feet, sixteen of 120 feet, and one of 160 feet on the Dundee side of the centre; and three of 60 feet, two of 80 feet, twenty-two of 120 feet, and fourteen of 200 feet on the Firth side. The experience gained in the course of the construction of the work rendered many alterations in this arrangement necessary. In the original design the piers were to be built of brick, set in cement, the foundations being produced by sunk cylinders filled with concrete. This plan was carried out on the Firth side with considerable success, the cylinders being sunk by the ordinary pneumatic process known as the "air-bell" process. Fifteen of the piers on the Fifeshire coast were thus erected, but on the 10th of March 1873, Mr. Charles De Bergue, the contractor, died, when progress was for a time checked, and new arrangements were rendered necessary. By this time also a considerable amount of work had been erected at the Dundee end of the bridge, where the piers were formed of hollow cast-iron tubes braced together with tie-bars, and sunk in the sand by means of a constant current of water forced through them. In July 1874, the completion of the work thus commenced was undertaken by Messrs. Hopkins, Gilkes, and Co., and the work, which had never actually stopped was resumed with vigour. For several reasons, Mr. Thomas Bouch, the engineer, at this time decided to modify his original design, and, instead of the plan above described, after very careful consideration, it was resolved to widen the centre spans, to adopt single large caissons, instead of two to each pier, and to make other important changes, which both added to the strength of the work and shortened the time required for its completion. The total length of the bridge is 10,321 feet, consisting of 84 spans, as follows:—

6	spans of	27	feet.
14	"	67	" 6 inches.
14	"	70	" 6 "
2	"	88	"
21	"	129	" 6 "
13	"	146	"
1	"	162	"
1	"	170	" bowstring girder.
13	"	245	"

Fourteen only of the piers, those on the Fife coast, are of brick, all the rest being of combined cast and wrought iron of various strengths, and composed of varying numbers of columns. The height of the largest girders above high water line is 88 feet, the line of rails being on a rising gradient from the Dundee end of about 1 in 73. The girders are of lattice construction, with double triangulation, and trough booms at top and bottom, from 15 in. to 24 in. in width according to the span, a vertical tie being fixed from the bottom boom to the crossing of the struts and ties, at every alternate crossing. The depth of the girders is one-eighth of the span. The cross girders are of pitch pine 12 in. by 9 in., the rails being carried on longitudinal beams 17 in. by 7 in., and the whole planked with 3 in. memel, covered with asphalte. A light hand rail of 2¼ in. (inside) gas tubes runs the whole length of the bridge, carried by metal stanchions. These tubes it is intended to utilise—the one to convey water and the other gas from one side of the Tay to the other. Across the long spans of 245 feet, the engines and trains will run between the girders, the rail platform resting on the bottom booms, but in all the other spans the trains will run on platforms fixed on the upper booms. The caissons employed for the larger spans are 31 feet in diameter, and about 20 feet deep, formed of wrought iron plates ⅜ in. thick, riveted together, and lined with brickwork 15 in. thick. Above this a further length of 20 feet of caisson was then built, and the whole floated out to its proper site, and sunk by means of sand pumps. As soon as the caisson was in position, it was protected from the scour of the water by depositing rubble stone round its base. As soon as it was sunk to the required depth, the centre was filled in with cement concrete, the upper portion was then removed, and on the concrete was placed a base for the pier constructed on shore, and floated out. This reached to the level of low water, and on it, as the tide permitted, men worked at the erection of the next section which reached to high water mark, where four courses of stone were fixed. On these were placed the iron columns, 12 in. and 15 in. in diameter, carrying the girders. When the piers were brought up to the proper height the girders were floated out on pontoons, and raised by means of hydraulic machinery to their respective sites. This bridge, the longest in the world, has been completed, and, having recently passed the Government inspection, is now ready to be opened for traffic. The test supplied to the bridge consisted of six engines, each 72 tons in weight, during the transit of which the greatest deflection recorded was only 1¾ inches.

WORKS ON THE GREAT WESTERN RAILWAY.

THE increasing traffic on the Great Western Railway has, for some time past, caused great inconvenience in the management of the train service within the Metropolitan District, and in order to obviate this, the Company has recently incurred very considerable expense in

laying down two new lines of rails, and in constructing new platforms and waiting rooms, besides, in some cases, entirely rebuilding the stations between Paddington and Southall, and it is intended to continue these improvements eventually as far as Slough. In connection with the general arrangements for facilitating traffic, it has been considered desirable to do away with the level crossing over the Great Western main line metals by the Metropolitan Railway, which was a constant source of delay to main line trains, besides being a standing element of danger. Since the extension of the Metropolitan system to Hammersmith, the trains on that line and the Great Western trains have crossed at points situated between the Ranelagh and Westbourne bridges, near the entrance to the goods station, and in order to obviate this inconvenience, a sunken way has been constructed between Westbourne Junction and the Royal Oak station for the use of the Hammersmith and City trains, and a rearrangement has been made of the main up and down trains of the Great Western between Paddington and Westbourne. Commencing at a spot opposite the west-end of the locomotive sheds, the sunken way dips with an incline of 1 in. 60, to a depth of 17 feet at its lowest part, extending for a distance of about half a mile to near the Royal Oak station. The sides of the cutting are formed of concrete walls, capped by coping bricks, and surmounted by a light iron hand-rail. The bottom of the cutting being below the sewage system, the drainage will have to be pumped out by means of a steam engine. This sub-way will provide a clear route for the Hammersmith and City trains, two lines of rails being laid in it for the up and down services. In order to provide space for the arrangements necessary to enable the Great Western Railway to cross the Hammersmith lines, the carriage sheds on the south of the railway have been demolished, and a route has been cleared by the side of the present Royal Oak station. On leaving Paddington the Great Western main line trains will pass on the south of the Royal Oak station, along the yard to a point about the middle of the sunken way, where the lines of rail are carried over the Hammersmith and City Railway upon strong iron girders, joining the main line near the east end of the locomotive depot. The carriage sheds having been demolished, it was necessary to provide accommodation for rolling stock, repairs, &c., on another site, and an extensive range of buildings have been erected for this purpose on the triangular space of waste land adjoining the Gas Works, near Wormwood Scrubs. It is expected that the sub-way will be opened for traffic in about a month from the present time.

HUXLEY'S PHYSIOGRAPHY.—Physiography is a subject not only interesting, but useful to the telegraph engineer. An intelligent knowledge of the natural phenomena of the earth's surface and the great processes of change perpetually going on in all countries is proper culture for a man who travels, and may be valuable education for an engineer. Professor Huxley's recent treatise on "Physiography" (Macmillan & Co.), is an excellent little manual of the subject in every way. It is pleasant to read, lucid in its explanation, and so admirably organised, that one has only to study it carefully from beginning to end, in order to form "a clear mental picture of the order which pervades the multiform and endlessly shifting phenomena of nature." Contrary to the usual practice in works on "Physical Geography" of beginning with a definition of the earth's figure and position in the solar system, Mr. Huxley begins with the firm ground of common experience, the features of a river basin, such as the Thames, and leads his readers by chapters on the nature and action of springs, rain, snow, the atmosphere, the sea, earthquakes, and volcanoes, coral and foraminifera, to a comprehension of the active agents of terrestrial change and the distribution of land and water; then deals with the figure of the earth and its movements round the sun. On the subject of ocean currents we find the following remarks at page 177. "During the recent voyage of the *Challenger*, the temperature of the sea at different depths was very carefully examined by means of instruments specially constructed to avoid sources of error. These observations shew that, as a rule, the temperature diminishes as you descend, just as was shown to be the case in the North Atlantic. Reference to fig. 45, shews that the bottom-water of that part of the ocean has a temperature only a little above 30° F.; while in other places it is still lower, and may even descend below the freezing-point of fresh water. It appears that the presence of such cold water in the deeper parts of the ocean, even in tropical regions, can hardly be explained otherwise than by assuming a grand movement of water from the polar towards the equatorial regions. Dr. Carpenter has brought forward much evidence to prove the existence of such a general oceanic circulation, and he refers the movement mainly to differences of density due to differences of temperature. The cold polar waters sinks by their density and form a deep layer, which creeps along the ocean-floor towards the equatorial regions; while the warmer and relatively lighter water floats on the surface in a contrary direction, or from equatorial towards polar areas. By such means, a complete circulation might be established; and it has consequently been said that every drop of water in the open ocean may, in course of time, be brought up from the greatest depths to the surface. Other meteorological conditions, however, may exert an influence of the same kind, as great as, or even greater than, that produced by difference of temperature. Sir Wyville Thomson regards the influx of cold water into the Pacific and Atlantic Oceans from the south as an indraught due to "the excess of evaporation over precipitation in the northern portion of the land hemisphere."

STEWART'S PATENT FLAG-SIGNAL FOR RAILWAY CARRIAGES.—In railway trains built up of isolated car-

riages, as those in this country invariably are, it becomes absolutely necessary as a matter of security to travellers for some means of inter-communication between the passengers and the guard or engine-driver of a train, to be provided. Many trains are now fitted up with a patented appliance, whereby the guard can be alarmed. The recent episode on the Midland Scotch Mail, however, in which the passengers in a compartment had for their own safety to get out and cling to the side of the carriage, while a free fight was going on inside between two drunken men, is a case which shews that although the appliance is ostensibly there, it is not always in working order. Mr. Stewart's system consists not only in ringing a bell to alarm the guard and the engine-driver, but in putting out a danger flag from the carriage in which help is required. Both acts are done simultaneously by the mere pulling of a cord which runs round the roof of each compartment, so as to be within easy reach of every person there. The pulling of this cord springs a trigger, liberating the flag which shoots out from the side of the carriage and unfurls itself in the air. At the same time, the flag-staff completes the circuit of a Léclanché battery, and rings a bell in the guard's van. The line wire is led along the top of the carriages, and the rails may be used as a return wire. The bell continues to sound until the flag is replaced and held back by its trigger, and as the position of the flag with regard to the carriage prevents the passengers from doing this, it can only be done by the guard answering the call. An electrical alarm is far more prompt and satisfactory than a merely mechanical one depending on the forcible pulling in of a slack cord. Mr. Stewart's has the merit of being simple, and above all of being readily accessible at every part of the carriage. The danger flag is also an important adjunct to the alarm bell, since it indicates the carriage at once to the guard, and can also be seen by porters or signalmen working on the line. Messrs. Heinke and Davis, Philpot-lane, are the makers of this appliance.

STEINER'S TASEOMETER.—Mr. Steiner, of Vienna, has lately constructed an apparatus for measuring the strains of structures, which he calls a "taseometer." Although the principle embodied in this instrument is not new, yet the construction of the apparatus is a decided improvement.

It is well known that the note given out by a stretched wire, or strip of metal, depends on the tension to which this wire or strip is subjected. Now, it has been already proposed to utilise this fact for measuring the strains on the various members of bridges or other structures. For this purpose a wire was to be stretched along the body or bar to be tested, and, as the ends of the wire would be firmly attached to the bar, the wire would vary in length by the same amount as the bar. It would thus only be necessary to measure the variation in length of the bar, and this was to be done by comparing the tone given out by it after the load had been applied to the bar, with that before the application of the load. As, however, this comparison had to be done by the ear, it is evident that no very exact results could be obtained, for it required a highly cultivated musical sense to discern various intervals of tones, the more so when the two tones are not sounded in immediate succession.

In Mr. Steiner's taseometer, this fault is done away with by automatic registration of the tones, the vibrating wire, or rather steel band, tracing its motions on a sooted surface in the same way as in the well-known phanantograph. The vibrations of a tuning fork, which is sounded at the same time, are shewn graphically on the same sooted surface, and serve as a standard by which the vibrations of the steel band are measured. Thus not only is any uncertainty in judging of the various tones avoided, but the tables with the vibratory curves inscribed on them can be also kept as lasting documents of the tests and experiments made, and the calculation of the strains from these curves can be done at leisure at any time and place that might be found convenient.—*Engineering.*

TRAFFIC ON THE METROPOLITAN RAILWAY.—At the last half-yearly meeting of the Metropolitan Railway Company, the chairman stated that 442 trains were run over the main line in 24 hours, and 568 on the widened lines, making a total of 1010 trains in that time. The first engine on the main line leaves the shed at 5'15 a.m., and the last engine reaches the shed at 1'15 next morning; on the widened lines work goes on throughout the 24 hours. During the day and night 46,826 telegraph bell signals, and an equal number of train signals are made. The manipulation of levers backwards and forwards to work the signals and points amounts to 66,958 times in the 24 hours; therefore in the mere signalling and working of the trains upon the block and interlocking systems, there are 160,000 operations daily performed by human hands, every one of which might lead to some mistake which might be more or less injurious.

NICKEL AND NICKEL-PLATING.—Until within the last few years, the only source for nickel was the "matte," or "speiss" ores, highly complex arsenides or sulphides of nickel, associated with cobalt, copper bismuth, and other metals. The cobalt had to be separated from the nickel by a special process. Recently, however, ores of nickel almost entirely free from arsenic, sulphur, copper, and other metals precipitable from acid solutions by sulphuretted hydrogen, have been discovered in New Caledonia. This ore consists essentially of hydrated silicate of nickel and magnesium, with iron sometimes associated. Silicate of nickel has already been found in other parts, for instance at Malaga in Spain, but ores so rich in the metal as the New Caledonian ores have never before been known. Former ores, in many cases, only gave three or four per cent. of the metal, but the new ore generally gives from ten to twenty-five per cent. The mineral is amorphous and traversed by fissures which

are often filled in with white silica in thin plates. It is of a bright green colour when rich in nickel, and almost rivals the lighter shades of malachite. Mr. Alfred H. Allen, F.C.S., in a paper to the chemical section of the Society of Arts, has published the results and methods of his analysis of it. At least half a dozen patents have been taken out for the extraction of nickel from the new ore. The ultimate product of every one of these processes is always pure oxide of nickel, which is reduced by heating it in pots along with charcoal. The masses known as "cube nickel," are made by mixing the oxide with wheat flower and water, so as to form a paste, which is cut into cubes and dried. These are heated in a crucible with plumbago powder and the pure metal is reduced. Commercial nickel varies much in quality; "nickel coins," so called, contain generally two-thirds of their weight of copper. Copper is not objectionable in nickel to be used for the manufacture of German silver, but the presence of traces of iron, sulphur, lead, and antimony should be carefully avoided. Like iron, nickel is rendered more fusible by the addition of a little carbon or silicon. "Pure nickel," says Mr. Allen, "is well known to require a very high temperature for its fusion, and when this difficulty is overcome, it is difficult to obtain the casting free of bubbles. Professor Winkler has recently achieved great success in this direction, and has obtained large and compact ingots of pure nickel and cobalt by ensuring a sufficiently high temperature, suitable pots, taking precautions to keep out carbon and silicon, and casting in an atmosphere free from oxygen. For the fusion he employs a porcelain crucible, which last is inserted in a graphite crucible and imbedded in fire clay. To obtain castings free from bubbles, it is found necessary to pour the metal into the mould through a flame of burning petroleum."

Nickel plates, for anodes in nickel-plating, are more and more in demand. The metal is melted in ordinary steel pots, a little borax or other flux being added. A small proportion of tin added to the metal makes it more fusible, and is not deleterious to the anode. Many patents have been taken out for the electro-deposition of nickel from solutions, but, practically, the only solution employed is the double sulphate of nickel and ammonium. It should not have a higher density than 1030, and should be alkaline rather than acid. The current should be carefully regulated, else the deposit loses its lustre. Almost any metal may be coated with a layer of any required thickness. For iron articles it is very well suited, and many pieces of telegraphic apparatus, such as the adjusting magnets of galvanometers, the iron poles of relays, and tongues of sounders, are now plated with it. The metal has a silvery white lustre, and is but little liable to tarnish in a fairly dry atmosphere, but fails to withstand continuous dampness. The New Caledonian ore is singularly well adapted for nickel-plating, and if it can be found in sufficient quantities we may expect a wide extension of nickel-plating.

GALLIUM.—Sixty-two grammes of the metal gallium were recently exhibited at a *séance* of the French Academy of Sciences, in the liquid form, in plates, in bars, and in magnificent crystals of many facets. To procure this quantity it was necessary to treat 5,000 kilogrammes of blende. The liquid metal resembles mercury in appearance, and, were it sufficiently abundant, might be employed in thermometers to indicate high temperatures, since it does not volatilise like mercury.

COLUMBIUM.—This little known metal was discovered in 1861 by Hatchett, an American chemist. He extracted it from a very rare mineral called columbite. It has hitherto been prepared in the form of a black powder, and its price was about a shilling per grain. Recently, however, it has been found in considerable quantities in the Amazon-stone of Colorado, and it is not unlikely that we shall hear more of it. In colour it comes between nickel and tin; it is lighter than tin; and in chemical properties it appears to come between tin and bismuth or antimony.

A NEW EXPLOSIVE.—It is said that Mr. Nobel, the inventor of dynamite, has discovered an explosive, even more potent, in "blasting gelatine." It is composed of 93 or 94 per cent. of nitro-glycerine, and 6 or 7 per cent. of collodion-cotton mixed together so as to form a gelatinous substance. It is tough, but may be cut with a knife or scissors, and may be made into cartridges, cakes, or balls.

A SCIENTIFIC COLONY in the artic regions is about to be established by the Americans, at Lady Franklin Bay, near where the coal seam was discovered by Captain Nares. Substantial buildings and provisions for three years are to be transported thither. Competent scientists, appointed by the National Academy of Sciences, and provided with the requisite apparatus for observations, are to form the principal members of the expedition. The telephone will be employed in maintaining communications, and balloons will also be made use of. It is thought that such a colony will in course of time become a base of operations from which parties may ultimately reach the pole.

City Notes.

Old Broad Street, March 14th, 1878.

WE hear that the Pouyer Quertier scheme is making steady progress. If it is not brought before the public until the French Exhibition is over, it certainly will afterwards, unless, indeed, as some think, there will be no necessity to ask for the support of the public. As we have already stated, half the capital has been subscribed privately, and it is more than probable that the other half will be obtained in the same way, in which case the monopolists may awake some fine morning and find the French Cable a stern reality.

It is highly satisfactory to learn from the managing director of the Black Sea Telegraph Company that

Mons. Lacoine has stated that during the recent repairs of the Constantinople to Odessa Cable, the Constantinople to Varna Cable of 1854 was hooked, and the portion taken out found to be in perfect condition after twenty-four years' immersion. No such striking proof of the durability of cables as this has hitherto been forthcoming, and it may well be a matter for congratulation amongst shareholders in telegraph companies all over the world. Twenty-four years is a long period, and if cables will remain perfect after all that time how long may they be expected to last?

At a meeting of the directors of the Indo-European Telegraph Company, on Tuesday, it was determined to recommend to the shareholders the payment of a dividend, for the year 1877, of 3 per cent., free of income tax.

A general meeting of the shareholders of the Great Northern Telegraph Company is announced to be held at Copenhagen on Saturday, the 6th of April. Some of the English shareholders may like to make the trip. The business to be transacted is not of an exciting character. A report of the business for 1877, and of the condition of the cables and all other property of the company, will be submitted, and one member of the board is to be elected.

It seems difficult to doubt that the majority of the shareholders of the Chatham and Dover Railway Company had substantial reasons, the other day, for definitely deciding against amalgamation with the South Eastern Company. But we take leave to observe that while the opponents of the fusion were, of course, at perfect liberty to oppose it, they were not justified in referring to the South Eastern Board in terms of something very similar to opprobrium. It does not follow that because certain noisy speakers at the Cannon Street meeting tried to show that the Chatham Company is all righteousness and the South Eastern Company the reverse, and certain sixth-rate newspapers with terribly limited circulation and still less honesty of purpose, find it to their advantage to thwart the proposed union, it was, therefore, supported by the South Eastern Board with the solitary object of benefiting South Eastern Shareholders at the expense of Chatham and Dover. As a matter of fact when the idea of fusion was first mooted, some of the persons who have lately been unable to discover language strong enough to denounce it, pronounced in its favour. It is now undoubtedly settled that the scheme is to be abandoned, and we do not know that it would serve any purpose to discuss the details of it. We content ourselves with two further observations. The insinuation of a paper which imagines it represents railway interests, closes a palpable puff of the Chatham Company and its boisterous panegyrists, with the intimation that the scheme was hurried on by the representatives of the Stock Exchange. To that extent we share the opinion of the print in question, although perhaps, we have a different opinion concerning the representatives themselves. But the last move of the representatives of the Stock Exchange seems to us to be worse than the first. It is true that the holders of Chatham stock are entitled to some commiseration, but the desperate expedient of trying to improve property by a demonstration against a competing company, may eventually recoil on the heads of those who are responsible for it. In the second place, whether the rupture between the companies—which were until recently on such a friendly footing towards each other—is a good or a bad thing, the notion of railway amalgamation of any kind may now finally be dismissed by the public. Possibly "enterprising" speculators may from time to time contrive to spread rumours of "negotiations," but even if the rumours are apparently backed by authority, our advice is, treat them with contempt, and above all, have no faith in the company which having striven for union retires from the scene, because it finds that the other company sets no higher value on its property than it deserves. In other words, profit by the examples of the Great Eastern, the Manchester Sheffield and Lincoln, and the Chatham and Dover Companies.

Perhaps it is right we should add that our strictures are not in any way directed at the chairman of the Chatham Company who almost went out of his way to say that he believed Sir Edward Watkin had acted as fairly and equitably towards the Chatham Company when the basis of the contemplated arrangement was made. We do not indeed assert that the opposition of the shareholders of the Chatham Company is not fully justified by the figures which have been placed before them, and as it is possible the fusion would not have worked for the advantage of the public, that may be one reason, at any rate, why it was not desirable. What we denounce is the course pursued at the Cannon Street meeting and elsewhere, by persons who previously supported the fusion, but who now can only deal out hard words to those who, like Mr. Branch think that what was good for the Chatham Company a year or two ago could not be so disastrous now. The interruption experienced by Mr. Branch was annoying, but the loud cheers which according to freely circulated pamphlets, greeted other speakers, have since been set down at their value.

We have spoken none the less freely about the abandonment of the fusion between the Chatham and South Eastern Companies because we have frequently felt it necessary to disagree, in the most decided manner, with Sir Edward Watkin. The circumstance that Sir Edward has now been paid with some of his own coin, and some even more alloyed, does not alter the fact that the chairman of the South Eastern Company and his co-directors have been unjustly vilified. It is likely that the break down of the proposed amalgamation with the Chatham Company will not tend to increase the dividend of the South Eastern Company for some time to come, for the competition which is often so advantageous to the public is frequently the cause of anxiety in the board-room of railway directors.

We have nothing to say touching the question at issue between Mr. James M'Henry, and certain of the proprietors of the Erie and Atlantic and Great Western Railway Companies. But there is one remark in the last circular published by Mr. M'Henry, which is well worthy of note. "Who would dare," asks Mr. M'Henry, "to propose as a remedy for the financial embarrassment of an English railway a sale by auction and destruction of all inferior creditors?" "A railway," he goes on, "cannot be benefited by foreclosure and sale, or by the 'wiping out' and 'scaling down' processes, familiar to American managers and lawyers, who appear to have no higher aim or juster knowledge of railway finance than to defy the owners, while squandering their proper revenues in enterprises destructive to the company and its customers. It was not by such means that the South-Eastern, Metropolitan, Brighton, or North British Railways, were elevated from disaster to prosperity." No, indeed, it was not; if such means had been used in the cases in question, we doubt whether either of the companies would have existed at the present moment. If there is much to be found fault with in the management and administration of railways, in this company, it is, at least certain, Americans themselves being judges, that the best thing some American companies could do would be to take a leaf out of the book of even one of the least successful.